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instruction manual

FCR 100

INSTRUCTION MANUAL

Sorensen

Sorensen & Company, inc.

Richards Avenue

South Norwalk, Conn.

UTL
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FCR 100

INSTRUCTION MANUAL

TABLE OF CONTENTS

I. GENERAL INFORMATION 1

II. SPECIFICATIONS. 2

III. INSTALLATION & OPERATION. 3

IV. PRINCIPLE OF OPERATION 5

V. MAINTENANCE & REPAIR 8

SORENSEN & COMPANY, INC. Richards Avenue, South Norwalk, Conn.

SB14-1994
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I. GENERAL INFORMATION

Before you begin to use your new Sorensen instrument, we suggest that you read this Instruction Manual very carefully. This information contained herein is designed to help you obtain the maximum in performance and many years of dependable service from your instrument.

A. Shipping Damage

The instrument should be inspected and tested immediately upon arrival. In the event the unit fails to operate properly or is damaged in any way, the carrier should be notified at once. When the claim agent has inspected the shipment and prepared a report of damage, a copy of this report should be sent to us. At that time we will advise you concerning the repair or replacement of the instrument.

B. Service and Information

All questions concerning the operation of malfunctioning of this instrument should be directed to the Service Department, Sorensen and Company, Incorporated, Richards Avenue, South Norwalk, Connecticut.

IMPORTANT

BE SURE TO INCLUDE THE MODEL AND SERIAL NUMBER IN ALL CORRESPONDENCE CONCERNING THIS INSTRUMENT. WITHOUT THIS INFORMATION WE MAY NOT BE ABLE TO GIVE YOU PROMPT AND ACCURATE SERVICE.

Should you receive a defective or damaged instrument or require service on an instrument within or outside of warranty, please write us. Be sure to include application, input line voltage, etc. The more information you give us, the faster we can handle your request.

In each case we will decide whether the instrument requiring service will be (a) returned to the factory, (b) shipped to a service station, or (c) serviced at your plant by one of our field engineers or representatives.

If the instrument should be returned to the factory, we will send you shipping instructions.

C. Shipments

All shipments to Sorensen should be prepaid unless we authorize to the contrary. The instrument should be wrapped in heavy paper and packed in the original container or a wooden box with at least three inches of shock absorbent material on all sides.

D. Warranty

This instrument is warranted by Sorensen & Co., Inc., to be free from defects in material and workmanship. Our obligation to the original purchaser under the warranty is limited to servicing the instrument and replacing defective parts (with the exception of tubes and fuses) when the instrument is returned to the factory with transportation charges prepaid. No other warranties may be implied.

The period of warranty is one year after the date of delivery of the instrument to the original purchaser.

Defects caused by improper operating conditions, accidents, misuse, or negligence and alteration or removal of the nameplate will void the warranty.

II. SPECIFICATIONS

Input Voltage Range	105 - 125 VAC
Input Frequency	45 - 65 cycles
Output Voltage Adjustment	115 VAC nominal 0 - 130 (Voltages under 75 volts have high distortion and modulation).
* Output Voltage Regulation	± 1% for load ± 1% for line
Output Frequency Range 1	45 - 300
Range 2	300 - 2000
Dial Calibration Accuracy	± 2%
Output Frequency Regulation	± 1% against all variations ± .01% may be obtained by using an external frequency standard
Frequency Drift	less than 1% over 24 hour period
Load Range	0 - 100 VA at 105 - 125 Volts output. Load derated at reduced output voltage with minimum load impedance of 110 Ohms.
Power Factor	Unity to 0.7 lagging at 100VA Unity to 0.5 lagging at 50VA Fully inductive at 25VA
Output Distortion	Max. 1% for 75V - 125V Output
** Output Modulation	Nom. 1% for 75V - 125V Output

Ambient Temperature Range 0 to 40°C. (32 to 104.0°F).

Tube Complement	5R4GY (2), 6X4, (1) OD3/VR-150 (2) 6BL7GT (1), 811A (2), 12AU7 (2) 12AT7 (1), 6F6GT (1), 6J7 (1)
Net Weight	75 Lbs.

* Voltage Regulation

The term. voltage regulation, of this unit assumes an oscillator input of fixed amplitude. This is a master oscillator power amplifier unit with no closed loop circuit. Therefore, the output voltage stability is only as good as the wein bridge oscillator. This oscillator is subject to drift due to shock, temperature, and aging effects and also has a frequency response of 1 db or less. The regulation referred to in the specification assumes a fixed oscillator voltage. The oscillator voltage specs. are as follows:

± 1 db vs. frequency
± 2% vs. mechanical shock
± 3% vs. temp. (0-35°C.)

** This figure assumes no input voltage modulation. If input voltage modulation is present, the output modulation will be directly affected by it.

III. INSTALLATION AND OPERATION

A. Terminals, controls

1. Input Connection

The input power is applied by means of a line cord utilizing a three prong plug. Since the third pring of this plug is connected to the FCR 100 chassis, connection of the line cord to the appropriate receptacle automatically grounds the equipment. If the user does not have three prong outlets available, he should use an adapter. The user should make sure that the extra wire (coded green) coming out from the adapter is solidly grounded to the power line wiring system (preferably soldered).

2. Stand-By Power

Power is obtained by turning to "On" the toggle switch, SW-1, at the left side of the instrument panel.

CAUTION: THE INPUT SWITCH, SW-1, DISCONNECTS THE INPUT LINE AFTER THE INPUT FUSE. FOR SAFETY REASONS THE INPUT LINE SHOULD BE DISCONNECTED EXTERNALLY PRIOR TO WORKING ON THE INSTRUMENT.

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3. Output Terminals

The output is available at two binding posts on the front panel and is isolated. The input circuitry is grounded to the chassis.

4. Output Voltage (On-Off)

The output voltage may be obtained by turning the "Output Power" toggle switch, SW2, to the "on" position. This is located on the right side of the instrument panel.

5. Output Voltage Adjust

The voltage adjust potentiometer R26 (located on the upper left center of the instrument panel) adjusts the output voltage from 0 to approximately 130 Volts. Voltages under 75 volts have higher distortion and modulation.

6. Frequency Range Switch

The Frequency Range Switch (SW3) located on the upper right center of the instrument panel will adjust the frequency in two ranges, from 45-300 or 300-2000 cps.

7. Auxilary Frequency Input

A jack (located above the output binding posts) is provided for using an external frequency source. In order to obtain the proper output voltage when using an external frequency source, an external signal of approximately 13 volts is required. This signal is fed into an impedance of approximately 100 K ohms.

B. Fuses

1. Fuse F-1 protects the input transformer T-1, and tubes, and is located on the lower left center of the instrument panel.

2. Fuse F-2 protects against output overload, and is located on the lower right center of the instrument panel.

C. Pilot Lights

1. Pilot Light 1 (PL1) located on the lower left of the instrument panel indicates filament power to be on.

2. Pilot Light 2 (PL2) located on the lower right of the Instrument panel indicates output power to be on.

D. Nameplates

Sorensen strongly suggests that the nameplate be retained even if the instrument is to be incorporated into other equipment. This will eliminate later difficulties if service or parts are required.

E. To Place the Unit in Operation

CAUTION: BEFORE OPERATION IS BEGUN, PLEASE REVIEW THE PRECEDING SECTION WITH REGARD TO CONTROLS.

1. Plug the input line cord into a 115V, 60 cycle outlet, as per A-1 above.

2. Turn on the "Stand-By" toggle switch at the lower left side of the instrument's panel. This will cause the pilot lamp PL1 to light and the filament power is now on.

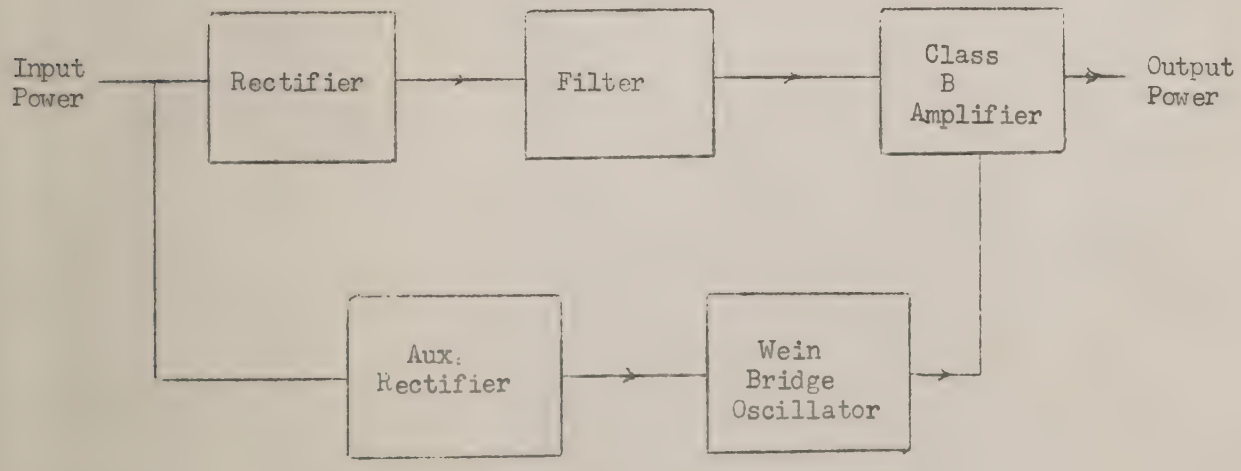
3. Wait approximately 30 seconds to give the tubes a sufficient warm-up period.

4. To apply output power turn the Output Power Switch (SW2), located on the lower right side of the instrument panel, to the "On" position. Pilot light PL2 should now light, and output voltage power should appear across the output terminals.

IV. PRINCIPLE OF OPERATION

The operation of this instrument can best be understood by referring to the schematic diagram supplied with each instrument.

A. The Block Diagram given below will aid in following the circuitry of the various section.



B. The frequency changer may be divided into three main sections with auxilary equipment. Refer to block diagram on previous page.

1. The main sections and their operations are as follows:

A. Rectifying section consisting of transformer T-1, Rectifier tubes V-1 and V-2, filter chokes L-1 and L-2, and filter capacitors C-1 and C-2. This section rectifies the input to provide DC power for the Amplifier section.

B. Amplifier Section consisting of transformer T-2, tubes V-4, V-5, V-11, V-12, and V-13, Audio Input Transformer T-4, and associated resistor and capacitor networks. This section is a class B Audio Amplifier employing a high degree of negative feedback to insure good output waveform and stability.

C. Wein Bridge Oscillator consisting of tubes V-8, V-9, and V-10. The Standard Wein Bridge Oscillator has components selected for two frequency ranges, 45-300 cycles and 300-2000 cycles. A plug and jack arrangement is incorporated for application of an external signal if desired.

D. Listed below are all the components used in this instrument, together with their function. They are presented for your understanding and as a reference source for the functionaldescription of items on the replacement parts list. Reference to the schematic furnished with each instrument will give the position of each component in the circuitry.

C-1, C-2	Filter capacitors main rectifier
C-3	Filter capacitor neg. bias for V-4 and V-5.
C-4	3 section filter capacitor, filters D.C. for oscillator and amplifier sections,
C-5,6,7,8,9, 10	Part of R-C, Potentiometer and neg. feedback circuit
C-11	Frequency adjust capacitor
C-12,14	Trimmer capacitors used to aline oscillator
C-13	Fixed capacitor used in oscillator alignment
C-15,17	Coupling capacitors in oscillator
C-18,23	High frequency filter capacitor in T-4 secondary
C-19,20,21,22	Coupling capacitors in Amplifier
C-24	Capacitor in load compensating circuit used to eliminate high frequency positive feedback
T-1	Input Transformer, filament and DC power
T-2	Output Transformer
T-3	Load compensating transformer
T-4	Audio Input Transformer
L-1, L-2	Filter chokes for main D.C. supply
L-3	Filter choke for oscillator D.C. supply
V-1, V-2	High voltage rectifiers for main D.C. supply
V-3	Rectifier for V-13 D.C. supply
V-4, V-5	Power Output tubes

V-6, V-7	Voltage Regulator tubes to regulate oscillator D.C. supply
V-8, V-9	Oscillator tubes
V-10	Cathode follower for oscillator output
V-11, V-12	Voltage Amplifiers
V-13	Cathode follower driver for V-4, V-5
R-1, R-2	Dropping resistors for voltage regulator tubes
R-3	Dropping resistor for D.C. supply for voltage Amplifier tube.
R-4	Adjustable dropping resistor for negative bias supply
R-5	Discharging resistor for one section of C-4
R-6, R-9	Cathode resistors of V-13
R-7, R-8	Grid resistors of V-13
R-41,42,43	Balancing network for plate current of V-4 and V-5
R-10,11,12,13	Resistors in R-C potentiometer network and negative feedback Circuit Amplifier
R-14	Adjustable resistor to provide proper current compensation
R-15	Range centering resistor in oscillator
R-37,38,39,40,47	Frequency determining resistors in oscillator
R-16	Plate resistor of V-8
R-17, 18	Screen grid divider resistor of V-8
R-19,20	Negative feedback resistors in oscillator
R-21	Plate resistor of V-9
R-22	Grid resistor of V-9
R-23	Cathode resistor of V-9
R-24,25	Screen grid divider resistors of V-9
R-26,46	Output voltage adjustment resistors
R-44	Stabilizing lamp bulb in negative feedback circuit of oscillator
R-27,28	Grid resistors of V-11
R-29,31	Plate resistors of V-11
R-30	Cathode resistor of V-11
R-32,33	Grid resistors of V-12
R-34,35	Plate resistors of V-12
R-36	Cathode resistor of V-12
SW-1	Input power switch
SW-2	Output power switch
F-1	Input power fuse
F-2	Output power fuse
SW-3	Range switch
P1	Auxilary frequency input plug
J1	Auxilary frequency input jack
S1	Selenium rectifier for negative bias supply V-4, and V-5
PL-1	Pilot light input power
PL-2	Pilot light output power

V. MAINTENANCE AND REPAIR

1. During normal life the unit requires no maintenance or servicing other than the care usually afforded this type of equipment. Tubes should be replaced at the end of their specified life in accordance with the policies established for the particular applications.

2. Spare Parts

All components in the Frequency Changer are of a good commercial grade and can be expected to give a reasonably long period of trouble free service. As the age of the instrument increases, however, some components are likely to deteriorate; we therefore suggest that the customer keep on hand the spare parts as indicated by an asterisk on the Parts List supplied with the unit. In the event it becomes necessary to replace any part, we strongly suggest that the replacement parts be of the same value as the original. Substitute parts should not be used unless we advise that the substitute part will not impair the performance of the instrument.

3. Repair and Trouble Shooting

In the event of malfunctioning of the unit due to deterioration or failure of any of its component parts, a systematic checking procedure will provide the quickest and surest method of locating the difficulty. The following section gives systematic checking procedures which should be followed in locating sources of trouble.

CAUTION: DANGEROUS VOLTAGES EXIST IN THIS INSTRUMENT. PLEASE OBSERVE APPROPRIATE PRECAUTIONS.

The first step in trouble shooting should be to replace tubes. In most cases this is enough to cure the trouble.

A. If the input power light does not light, check F-1. If it still does not light check the input connection.

B. If the output switch is turned on and no output voltage appears when the voltage potentiometer is turned up the difficulty is in the oscillator section. Check to see that the oscillator section is providing the proper voltage by placing a V.T.V.M. across terminals #1 and #5 of oscillator assembly plug. A reading of 10-15 Volts should be obtained for a 115 Volt output.

If no voltage appears across these terminals, check the following:

1. Check Fuse F-2.

2. R-44 located on the chassis under the oscillator assembly may be open or loose. A resistance check of this resistor should read between 350 and 500 ohms with the standard multimeter.

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3. Check potentiometer R-19; this potentiometef is factory set for proper negative feedback in the oscillator circuit. If this potentiometer becomes jarred or if the tubes are changed in the oscillator section, the oscillator may fail to provide proper output voltage. Raising the resistance of this potentiometer should provide output voltage.

4. Capacitor C-11 rotor should be isolated from ground, if any part of this circuit becomes grounded, the oscillator circuit will not provide output voltage.

In the event that these checks do not help. the entire oscillator section should be checked.

C. If the oscillator voltage's are proper and still no output voltage appears check the following:

1. Check the following D.C. Voltages:

A. From chassis ground to terminal No. 2 of L-1, 1100-1400 V.D.C.
B. From chassis ground to junction of R-2, L-3, and V-6, 300 V.D.C.
C. From chassis ground to junction of R-3, and C-4, 350-425 V.D.C.
D. From chassis ground to plate of V-13, 450 V.D.C.
E. From chassis ground to C-3, negative 50 V.D.C.
F. From chassis ground to R-30, 9 V.D.C.
G. From chassis ground to R-36, 9 V.D.C.

If all the voltages are correct and there is still no output voltage check resistance values and continuity.

D. If any of the following conditions exist, the internal adjustments are possibly incorrectly set.

1. High distortion
2. Poor frequency calibration
3. Insufficient output voltage
4. Poor load compensation
5. Excessive bounce in output
6. Excessive voltage change with frequency change.

In the event that any of the interna l adjustments are incorrectly adjusted, we strongly suggest you contact the factory for further service instructions.

E. Shown below are a number of waveforms to use as a means of checking the circuitry. The waveforms were taken with a nominal input at both no load and full. The voltages were measured with a standard V.T.V.M.

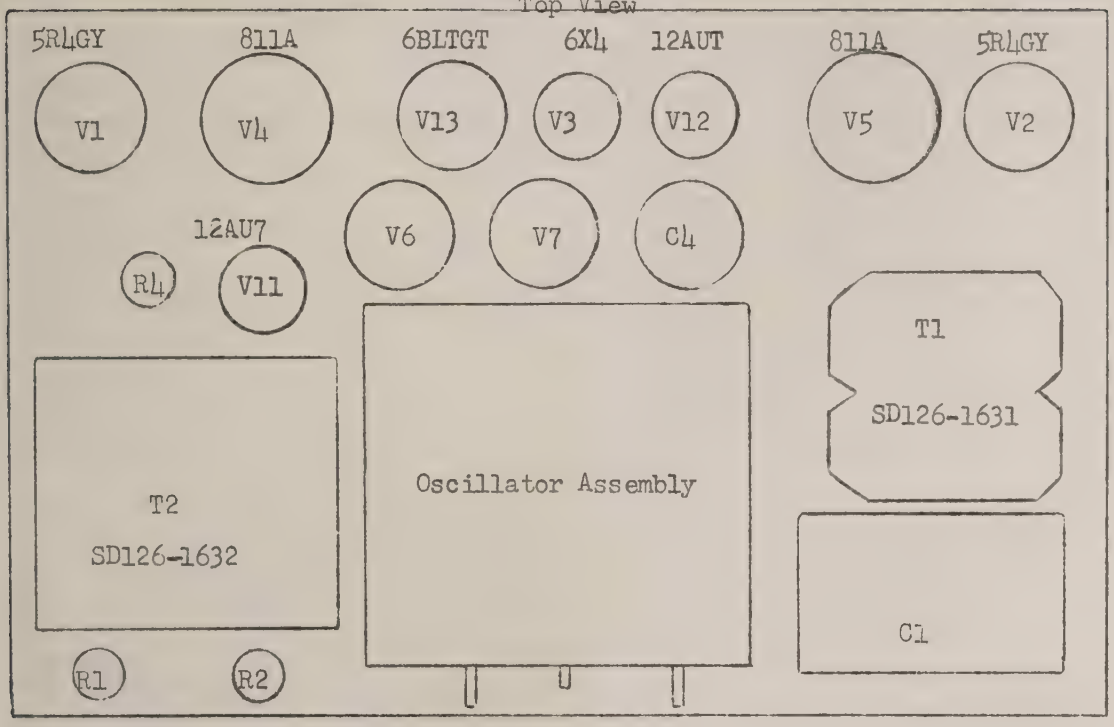
A.C. Readings Using Ballantine and Scope

V11 Pin #7 to B-		V11 Pin #2 to B-		V12 Pin #1 to B-		V12 Pin #6 to B-		V13 Pin #3 to B-		V13 Pin #4 to B-	
N.L.	F.L.	N.L.	F.L.	N.L.	F.L.	N.L.	F.L.	N.L.	F.L.	N.L.	F.L.
.48	1.1	.26	.43	7.8	50	11.0	56	10	36	7.6	47

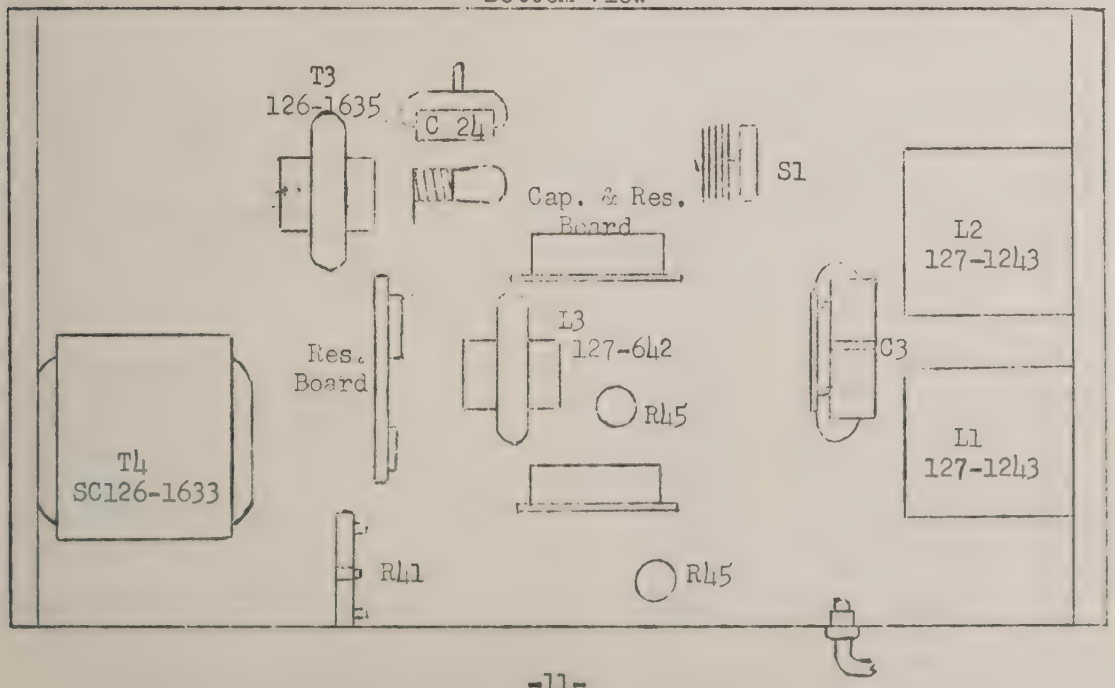
V11 Pin #1 to B-		V11 Pin #6 to B-		T4 1A-1B		T4 7A-5B		T3 1-2		T3 3-4	
.52	4.0	1.0	4.8	10.5	11.5	9.4	10.0	.04	1.0	.018	.43

In the event of serious difficulty or damage to this instrument, we strongly suggest that consideration be given to returning it to the factory for repair.

Component Layout
Top View



Bottom View



REPLACEMENT PARTS LIST

Model FCR-100

Serial No. ..... to .....

c	Description	Sorensen Part No.	Specifications
	Res. 7.5K 50W	27-886	W.L. 50F7500
	Res. 100K 25W	27-726	W.L. 25F
	Res. 1K 10W adj.	27-522	Ohmite #1023
	Res. 25K 10W	27-529	W.L. 10F
	Res. 10K 2W	27-305	Allen Bradley HB1031
2,32,33	Res. 470K 1/2W	27-146	Allen Bradley EB4741
	Res. 2.2 meg. 2W 1%	28-522	IRC Type DCH
,27,28	Res. 33K 1/2W 1%	27-969	IRC Type DCC
	#21 Cupron	21-017	
	Pot. 50K 1W	29-207	Chicago Tel. Co. Type 45
,29,31,	Res. 100K 1W	27-232	Allen Bradley GB1041
	Res. 47K 1W	27-223	Allen Bradley GB4731
	Pot. 1K 3W	29-060	Clarostat 58-1000
	RES. 2K, 1/2W 1%	28-320	I.R.C. TYPE DCC
54	Res. 15K 10W	27-528	W.L. 10F
	Res. 820 ohm 1W 1%	27-992	IRC Type DCF
	Res. 10K 10W	27-527	W.L. 10F
	Pot. 100K 1W	29-206	Chicago Tel. Co. Type 45
	Res. 47K 1/2W	27-112	Allen Bradley EB4731
	Res. 3.3K 1W	27-292	Allen Bradley GB3321
	Res. 580K 1/2W	27-988	IRC Type DCC
	Res. 4 meg 1W	27-993	IRC Type DCF
	Res. 10K 10W adj.	27-526	W.L. 10A
	Res. 27K 1W	27-217	Allen Bradley GB2735
	Lamp Bulb	42-312	G.E. #10S6/10-230 S
	Res. 1K 25W	27-727	W.L. 25F
	RES 47K, 1/2W, 5%	27-945	I.R.C. TYPE MBC
	RES 47K, 1/2W, 5%	27-945	I.R.C. TYPE MBC
9,50,51,52,53	Res. 330K	27-243	G.B. 3345
	RES 10K, 50W	27-545	WARD LEONARD 50F10000
	Cap. 100 mfd 150 VDC	24-144	Sprague Atom TVA-1420
	Cap. 40/40/10 450-450-500 VDC	24-475	Mallory FP398
	Cap. .2 mfd 200 VDC 2%	24-615	C.D. Type TWS2P2 -2-2
	Cap. .003 mfd 3750 VDCW, 7500 VOLT	24-038	Aerovox 1653L
	Cap. Variable	24-029	Radio Cond. Co. Ser. 19, Type C
*	Cap. 7 to 45 mmfd 600 VDC	24-020	Centralab No. 822-BM
	CAP. 33MMFD, 500VDC	24-030	C.D. 22R5Q33
,20,21,22	.5 mfd. 400 VDC	24-117	C.D. PJ4P5
	Cap. 8 mfd 450 V	24-436	C.D. BR-10368-1
	Cap. .002 mfd 500 VDC	24-019	EL-Menco CM 25-D-202-G
	Cap. 25 mfd 10V	24-156	C.D. Brex 7941
,27,28			
	Cap. 80 MFD 450 VDC	24-426	C.D. UP8045

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ic drawing

200-1212

*
RECOMMENDED SPARE PARTS: This instrument normally requires the replacement only of tubes, pilot lamps, etc. However because of possible improper use, and because of the effects of high ambients and of certain kinds of tube failures (and of protective devices) we suggest that the parts marked with an asterisk be kept on hand. PLEASE REFERENCE THE MODEL AND SERIAL NUMBERS ON ALL PARTS ORDERS.

List No. SB14-1949

Page 1 of 2

Prepared by J.C.

Date .....

REPLACEMENT PARTS LIST

Model FCR-100

Serial No. ..... **to** .....

	Description	Sorensen Part No.	Specifications
	Tube 5R4GYB	12-097	Commercial
	Tube 6X4	12-038	Commercial
	Tube 811A	12-084	Commercial
	Tube OD3/VR-150	12-004	Commercial
	Tube 6J7	12-082	Commercial
	Tube 6V6GTA	12-037	Commercial
	Tube 12AT7	12-083	Commercial
*	Tube 12AU7	12-091	Commercial
	Tube 6BL7GT	12-070	Commercial
	Sel. Rect.	26-907	Sarkes Tarzian Model 100
	Input Trans.	126-1631	Sorensen & Co., Inc.
	Output Trans.	126-1632	Sorensen & Co., Inc.
	Comp. Trans.	126-1635	Sorensen & Co., Inc.
	Audio Input Trans.	126-1633	Sorensen & Co., Inc.
	Choke	127-1243	Sorensen & Co., Inc.
	Choke	127-642	Sorensen & Co., Inc.
	Fuse 6¼ amp 3AG	42-844	Littelfuse 3136.25
	Fuse 1 amp 3AG	42-406	Littelfuse 313001
	Fuseholder 3AG	42-459	Littelfuse 342003
	Switch SPST Toggle	45-102	Cutler Hammer 7501K12
	Switch DPST Toggle	45-112	Cutler Hammer 7561K5
	Switch	90-1357	Sorensen & Co., Inc.
*	Pilot Lite	42-301	G.E. NE51
	Pilot Lite Holder	42-370	E.F. Johnson #147-1144-6
	Jack	42-959	Mallory 702A
	Plug	42-582	Mallory 75A
	SWITCH DPDT.	45-118	CUTLER HAMMER #8373K8

VISION	A - 6V6GTA WAS 6F6 EN 1-3175	4-B-63	F.C
	B - ADDED VALUES TO R46, R47, R20 & C13 EN	8-27-63	F.P

erence see
ic drawing

0-1212

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Page 2 of 2

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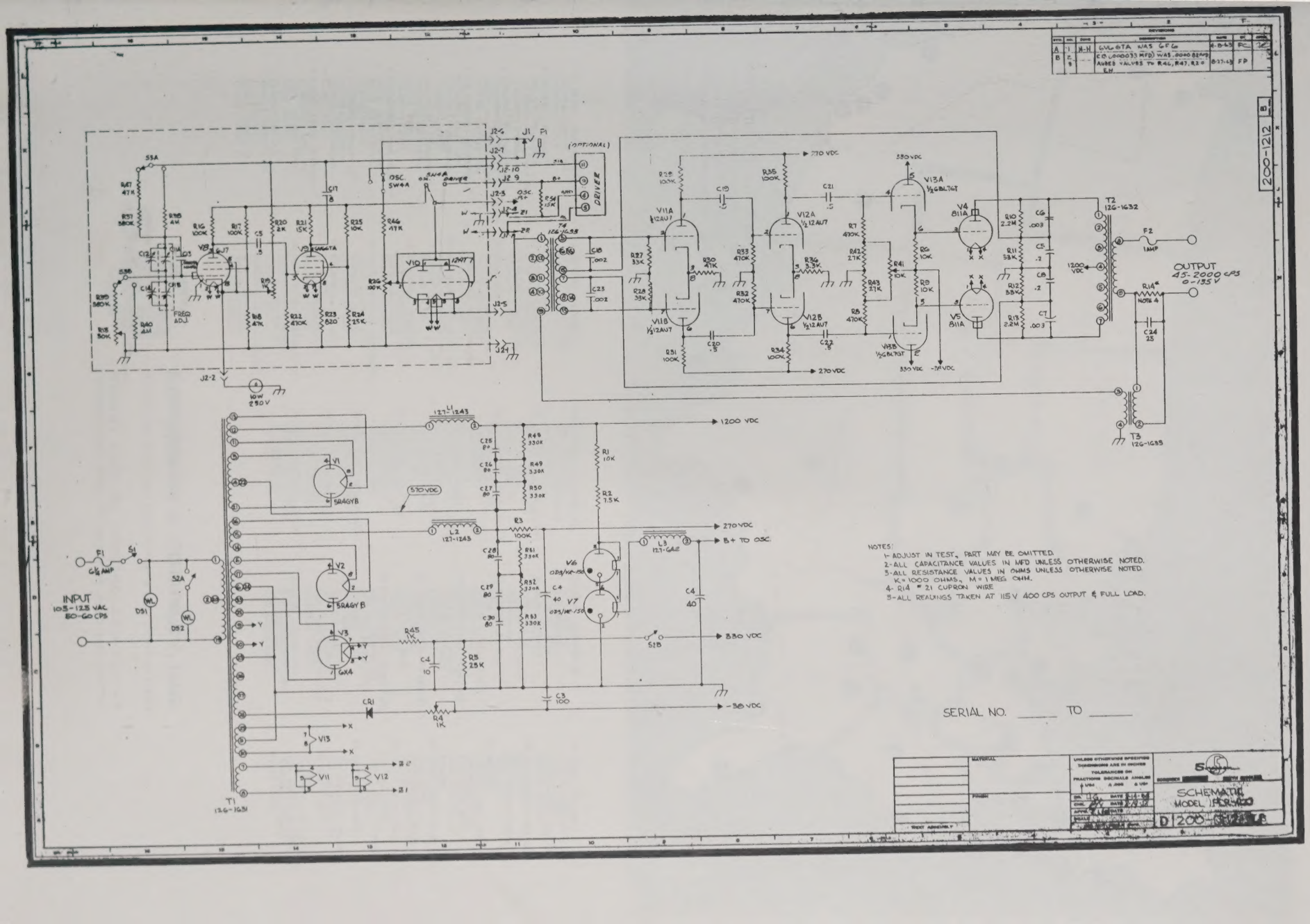
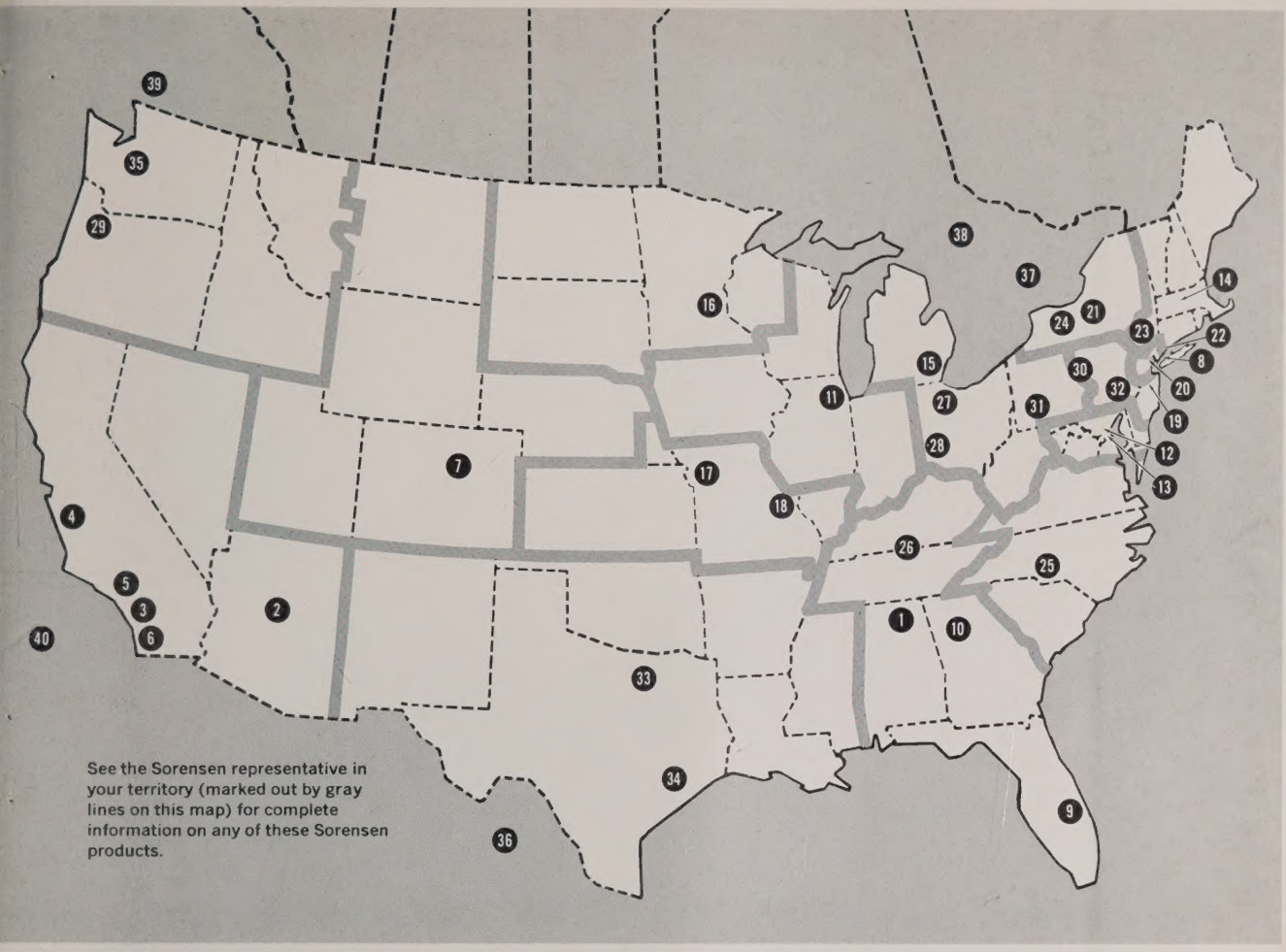

200-1212 B
INPUT
105-125 VAC
50-60 CPS
OUTPUT
45-2000 CPS
0-135 V
1200 VDC
270 VDC
330 VDC
-38 VDC
570 VDC
T1
126-1631
T2
126-1632
T3
126-1633
NOTES:
1- ADJUST IN TEST, PART MAY BE OMITTED.
2- ALL CAPACITANCE VALUES IN MFD UNLESS OTHERWISE NOTED.
3- ALL RESISTANCE VALUES IN OHMS UNLESS OTHERWISE NOTED.
K = 1000 OHMS, M = 1 MEG OHM.
4- R14 = 21 CUPRON WIRE
5- ALL READINGS TAKEN AT 115 V 400 CPS OUTPUT & FULL LOAD.
SERIAL NO. _____ TO _____
SCHEMATIC
MODEL PSR-400
D1200


See the Sorensen representative in your territory (marked out by gray lines on this map) for complete information on any of these Sorensen products.

1 ALABAMA — Huntsville *
Bivins & Caldwell, Inc.
JEfferson 2-5733

2 ARIZONA — Phoenix *
McCarthy Associates
111 Osborn West, Suite 213
CRestwood 9-1891

3 CALIFORNIA — Hollywood
Sorensen's West Coast Warehouse
Bekins Warehousing Corp.
1025 No. Highland Ave.

4 CALIFORNIA — Menlo Park *
McCarthy Associates
635 Oak Grove Avenue
DAvenport 6-7937

5 CALIFORNIA — Pasadena *
McCarthy Associates
1055 E. Walnut
SYcamore 2-8272

6 CALIFORNIA — San Diego *
McCarthy Associates
934 W. Laurel Street
BElmont 9-4015

7 COLORADO — Denver 10 *
Lahana & Company
1886 South Broadway
PEarl 3-3791

8 CONNECTICUT — Bridgeport *
Yewell Associates, Inc.
1101 East Main Street
FOrest 6-3456

9 FLORIDA — Orlando *
Bivins & Caldwell, Inc.
P. O. Box 6025
1226 E. Colonial Dr.
CHerry 1-1091

10 GEORGIA — Atlanta 5 *
Bivins & Caldwell, Inc.
3133 Maple Drive, N. E.
CEdar 3-7522

11 ILLINOIS — Chicago 45 *
Pivan Engineering Co.
2820 Peterson Avenue
BRiargate 4-9135

26 KENTUCKY
Bivins & Caldwell, Inc.*
1923 N. Main Street
High Point, North Carolina
High Point 2-6873

12 MARYLAND — Baltimore 15 *
Horman Associates, Inc.
3006 W. Cold Spring Lane
MOhawk 4-8345

13 MARYLAND — Rockville *
Horman Associates, Inc.
941 Rollins Avenue
HAzelwood 7-7560

14 MASSACHUSETTS — Burlington *
Yewell Associates, Inc.
Middlesex Turnpike
BRowning 2-9000

15 MICHIGAN — Detroit 35 *
S. Sterling Co.
15310 W. McNichols Rd.
BRoadway 3-2900

16 MINNESOTA — Minneapolis 3 *
Pinkney & Hine Company
1925 Nicollet Avenue
FEderal 8-0523

17 MISSOURI — Kansas City 30
Harris-Hanson Co.
7916 Paseo Avenue
HIghland 4-9494

18 MISSOURI — St. Louis 17
Harris-Hanson Co.
2814 S. Brentwood Blvd.
MIssion 7-4350

19 NEW JERSEY — Asbury Park *
The I. E. Robinson Co.
905 Main Street
KEllogg 1-3150

20 NEW JERSEY — Englewood *
RMC Associates, Inc.
391 Grand Avenue
LOwell 7-3933

21 NEW YORK — Dewitt*
J. D. Ryerson Associates, Inc.
111 Kinne Road
Syracuse—GIbson 6-1771
Mail: P. O. Box 1400,
Syracuse, N. Y.

22 NEW YORK — New York*
RMC Associates, Inc.
236 E. 75th Street
TRafalgar 9-2023

23 NEW YORK — Poughkeepsie *
Yewell Associates, Inc.
806 Main Street

24 NEW YORK — Rochester 18 *
J. D. Ryerson Associates, Inc.
105 Pickwick Drive

25 NORTH CAROLINA — Charlotte 5
James L. Highsmith Co.
3733 Monroe Rd.
FRanklin 7-2546

27 OHIO — Cleveland 24 *
S. Sterling Co.
5827 Mayfield Rd.
HIllcrest 2-8080

28 OHIO — Dayton 2 *
S. Sterling Co.
379 West First Street
FUlton 8794

29 OREGON — Portland 9 *
ARVA
1238 N. W. Glisan Street
CApital 2-7337

30 PENNSYLVANIA — Camp Hill *
The I. E. Robinson Co.
2120 Market Street
REgent 7-6791

31 PENNSYLVANIA — Pittsburgh 27 *
S. Sterling Co.
4024 Clairton Blvd.
TUxedo 4-5515

32 PENNSYLVANIA — Upper Darby*
The I. E. Robinson Co.
7404 West Chester Pike
FLanders 2-7017

26 TENNESSEE
Bivins & Caldwell, Inc.*
1923 N. Main Street
High Point, North Carolina
High Point 2-6873

33 TEXAS — Dallas 9*
Earl Lipscomb Associates
P. O. Box 7084
FLeetwood 7-1881

34 TEXAS — Houston 5 *
Earl Lipscomb Associates
P. O. Box 6646
3825 Richmond Avenue
MOhawk 7-2407

35 WASHINGTON — Seattle 9*
ARVA, Inc.
1320 Prospect Street
MAin 2-0177

36 MEXICO
ELECTRO LABS., S.A.*
Guanajuato #115
Mexico City, Mexico
Tels: 11-60-94, 11-70-58

CANADA

37 BAYLY ENGINEERING, LTD.*
Hunt Street
Ajax, Ontario, Canada
Toronto: EMpire 2-3741

38 BAYLY ENGINEERING, LTD.*
48 Sparks Street
Ottawa, Ontario, Canada
CEntral 2-9821

39 BRITISH COLUMBIA
ARVA *
355 Burrard St.—Room G7
Vancouver 1, B. C.
MUtual 1-3367

40 HAWAII
GENE PIETY FACTORS, INC.
2030 Home Rule Street
Honolulu 17, Hawaii
Phone 83105

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